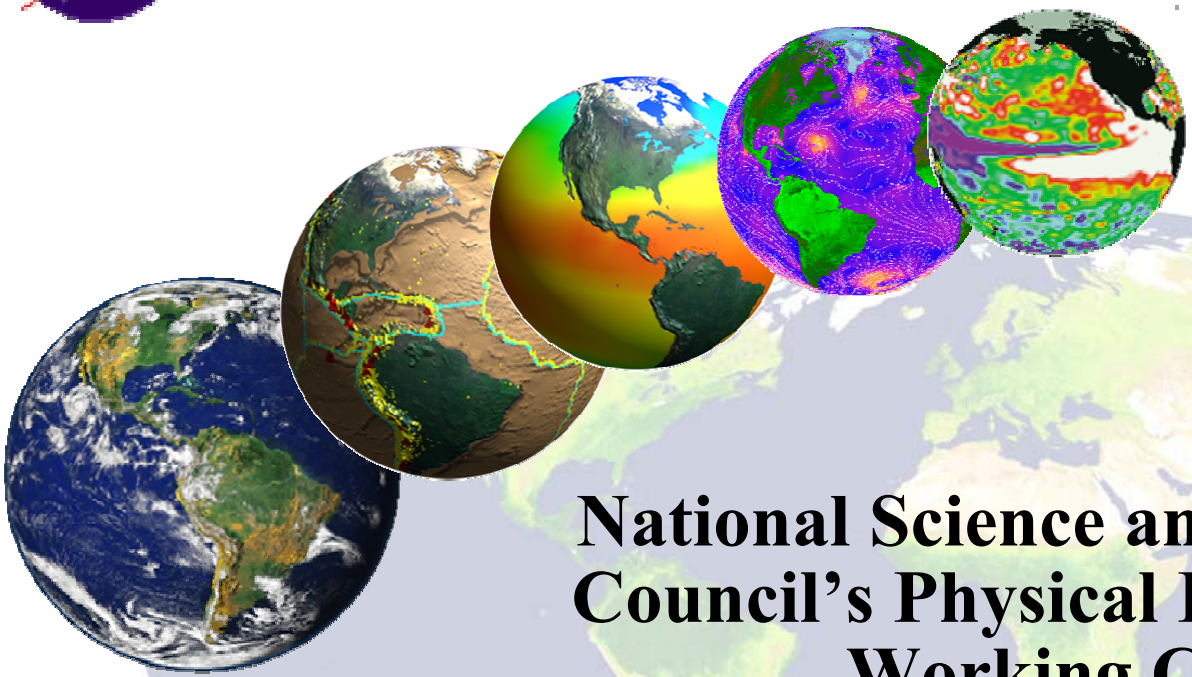
Earth Science Enterprise



National Science and Technology Council's Physical Infrastructure Working Group

November 21, 2003

Patricia A. Weir
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Ph: 301.286.3411
NASA's Geospatial Interoperability Office (GIO)


The NASA Vision
To improve life here,
To extend life to there,
To find life beyond.
The NASA Mission
To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
... as only NASA can.

“Understand and protect our home planet”

Earth Science Enterprise Mission:

Develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations

Applications of National Priority

Carbon Management

Public Health

Energy Management

Aviation

Water Management

Homeland Security

Coastal Management

Disaster Management

Agricultural Efficiency

Invasive Species

Ecological Forecasting

Air Quality

Earth Science Applications Purpose

NASA Earth Science Enterprise Applications

- conducts research and development of aerospace science and technology
- to increase knowledge of the Earth system
- to improve decision support tools to serve society

Related NASA Websites

- www.nasa.gov
- www.earth.nasa.gov
- http://www.earth.nasa.gov/visions/index.html
- http://www.earth.nasa.gov/eseapps/
- http://gai.fgdc.gov

NASA conducts systems engineering and scientific research to serve Earth system science solutions focused on national priorities -- including economic, environmental, and homeland security.

National Applications: Approach

Applications Research

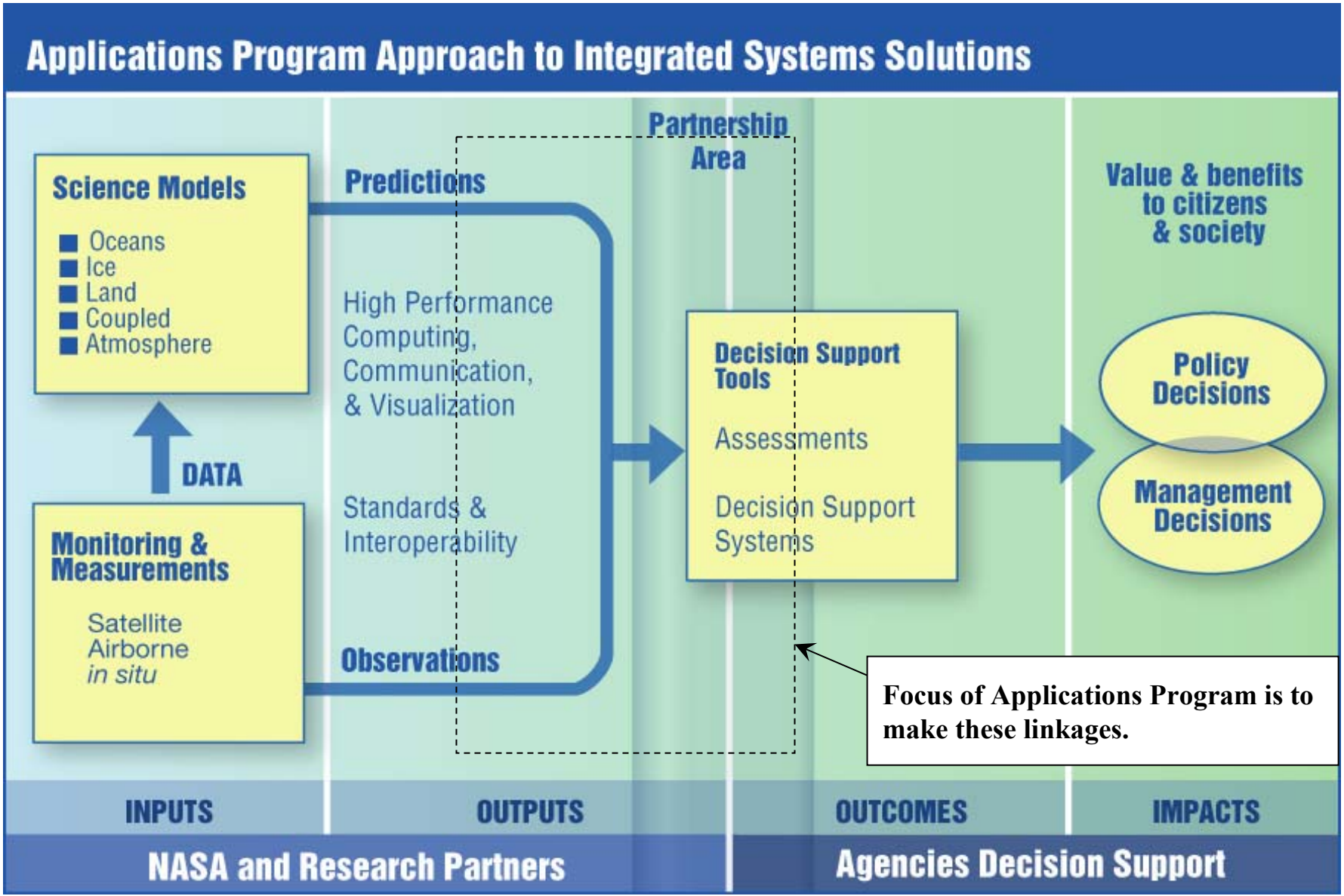
- Extend scientific findings to requirements of operational environments
- Identify designs for information and data products – particularly to enable use by automated systems

- **Verification and Validation**
- Evaluate and verify results of technology & operational technique
- Identify improvements for information products

- **Applications Benchmark & Deployment**
- Document prototypes, guidelines, and procedures for potential operational implementation

The desired outcome of applications projects is for the partner organization to use the resulting prototypes, processes, and documentation as benchmarks for operational use.

Integrated Systems Solution Approach- From Science to Decision Support



Contributions to National Agenda

- **Climate Change Science Program**
  - Goal 5 – Observations and Predictions for Decision Support
- **Climate Change Technology Program**
  - Measurement & Monitoring Capabilities for GHG Stabilization
- **Interagency Working Group on Earth Observations**
  - U.S. 10-Year Plan for Earth Observation System(s)
- **Commercial Remote Sensing Implementation Plan**
  - Joint Agency Committee on Imagery Evaluation
- **Geospatial One Stop**
  - Federal Portal and Procedures for Earth Observations
- **President's Initiative on Illegal Logging**
  - Rapid Response Systems for Forest Monitoring

NASA's Geospatial Interoperability Office (GIO)

GIO Program: Who We Are

Level II function that directly supports the ESE Applications strategy and manages NASA participation in Geospatial Standard committees (i.e. FGDC, OGC, ISO TC211)

- Customers: HQ/ESE, CIO & Code JX , ESDIS, SEEDS, ESTO, Federation, Synergy, and all NASA Centers
- Alignment/Collaborations: FGDC/GAI WG, IEEE, ISPRS/ASPRS, Digital Earth, etc.
- Agency advocate on geospatial interoperability
- Provides Agency focus for Federal Mandates such as Geospatial One-Stop (GOS) & Federal Enterprise Architecture (FEA)
- Develops Agency consensus on geospatial interoperability standards--beyond the scope of individual projects

GIO Program: Goal & Objectives

- **Goal:** Enable government, industry, scientists and citizens to gain knowledge or make decisions through application of geospatial information
- **Objectives:**
  - Geospatial Standards Leadership
  - Partnerships / Alignments
  - Support and leadership in President's Management Agenda
  - Support of ESE National Applications
  - Outreach & Education
  - International Representation

NASA's National Applications Disaster Management

Disaster Management

Integrated System Solutions

EARTH SYSTEM MODELS

- Earthquake: *MMI, Quakesim*
- Hurricane: *WAVEwatch*
- Flood:*SLOSH,*
- Land: *GPS Network*
- Building Cost Models: *ATC-13*
- Building Structure Models: *EPEDAT* ***Supported Non-NASA Model***

Predictions

- Earthquake prediction
- Floods
- Hurricane & Typhoons

Data

MONITORING & MEASUREMENTS

- **Land:** *Landsat, SRTM,*GPS, SCIGN, Terra, Aqua
- **Ocean:** *QuickSCAT*
- **Atmosphere:** TRMM, **GPM***

***Future Mission**

- Land Surface Topography
- Global Precipitation
- Ocean Surface Winds
- Surface Deformation
- Motions of the Earth's Interior

Observations

DECISION SUPPORT TOOLS

- **HAZUS** Multi Hazard
- Disaster Recovery/ Mitigation
- Land use decision
- Potential economic loss
- Estimation of direct damage, induced damage, direct losses, and indirect losses
- Accurate risk prediction to communities
- Loss estimates of buildings, essential facilities, transportation & utility lifelines, and population
- Social impacts

VALUE & BENEFITS

- Identify/ Prioritize high-risk communities
- Reduction in lives lost
- Reduction in damage cost
- Anticipate the scope of disaster-related damage
- Improve disaster response
- Community Planning

Disaster Management:

HAZUS-MH - Risk Assessment and Loss Estimation

S. Ambrose, 6/17/2003

State 2-HAZUS-MH:
Earthquakes
Hurricanes
Flooding
Tornadoes
Homeland Security
Fire

Primary Partners:

Socioeconomic Impact

Transfer of advanced event-modeling capabilities using next-generation hardware, software, and communications

Outcomes: Improvement of FEMA capabilities across all hazards and phases

Impacts: Reduce losses acro all disasters

Provision of real-time weather products for FEMA response applications

Outcomes: Improvement of FEMA response capabilities to weather and natural hazards

Impacts: Reduce losses across all weather-driven disasters

Provision of EOS standard products with minimal time delay for DHS/FEMA response applications

Outcomes: Improvement of the HAZUS High Winds Module Final Version

Impacts: Reduce losses related to hurricane and high wind disasters.

Landsat-7 data for characterization of Forest species type, canopy structure, biomass, and tree height, width, and crown. Lightning detection and mapping.

Outcomes: Improvement of the HAZUS High Winds Module

Impacts: Reduce losses related to hurricane and high wind disasters.

FEMA-37 Floodplain Mapping Standard, Incorporate Wavewatch into HAZUS

Outcomes: Improvement of all US Floodplain Maps feeding the HAZUS Flood Module Model Assessments

Impacts: Reduce losses related to flood and wind disasters.

State 1-HAZUS: Earthquakes

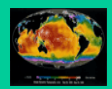

SeaWiFS

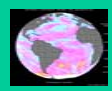

Terra


Jason-1


Aqua


SeaWinds


OcnTopo


* OSWinds

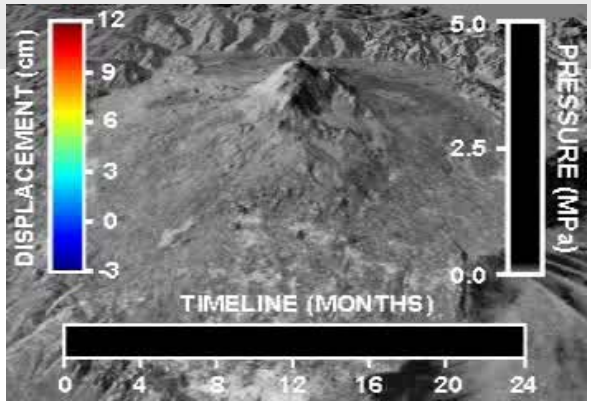

NPOESS

* Pre-formulation

2003 2004 2005 2006 2008 2010 2020

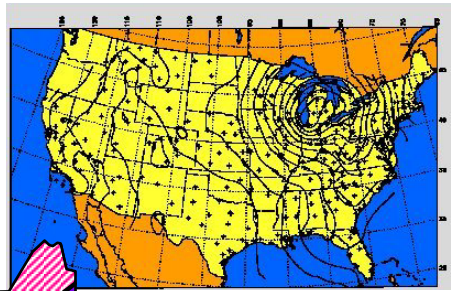
An operational decision support system for quantification and verification of solutions for natural hazard predictions.

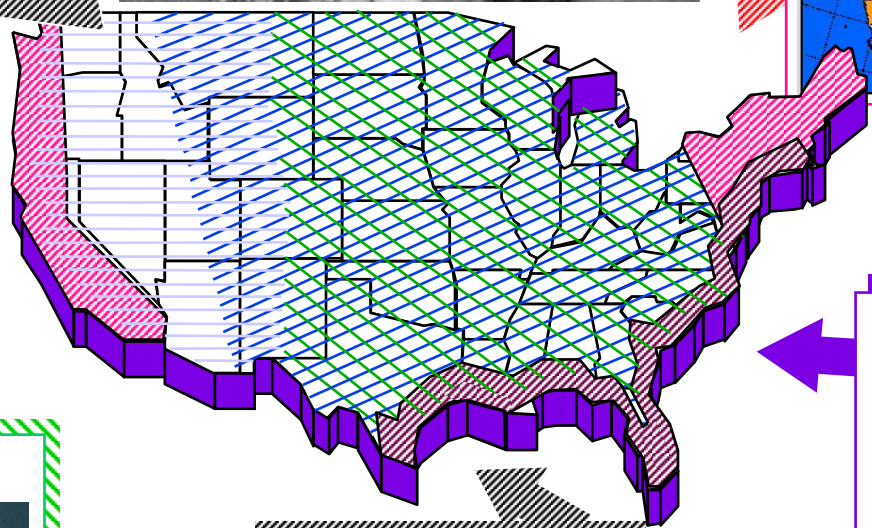
Earth Science for Disaster Management



Thunderstorms and Hail

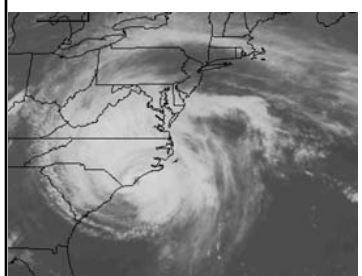
Extratropical Cyclones



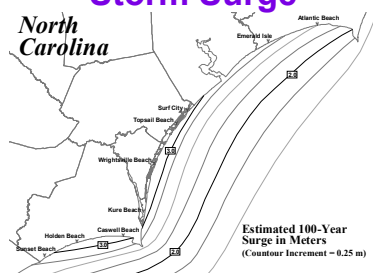


Tornadoes

Hurricanes



Storm Surge



NASA's National Applications Energy Management

Energy Management

Integrated System Solutions

EARTH SYSTEM MODELS

- Earth System & Climate Change: *DAO Analysis, NCEP Analysis*
- Seasonal Prediction Models: *NSIPP Analysis, NCEP Analysis*
- Aerosol Transport Models: *RAQMS, DAO fvCAM, NCAR WRF, GFDL FMS Atmosphere*
- Climate Models: *GISS Model II, GFDL FMS B-Grid Atmosphere*
- Atmospheric Analysis Models: *ISCCP, SRB, CERES-SARB, GVAP, GPCP*

**Supported Non-NASA Model*

Data

MONITORING & MEASUREMENTS

- **Atmosphere:** *GOES, POES, TRMM, Terra, Aqua, TOMS, Aeronet, AIRNow, INTEX, Aura, Calipso APS,CloudSat, GPM, NPP*
- **Land :** *Terra, Aqua, Landsat, Terrestrial Networks, BSRN, ARM, SURFRAD, GIFTS*
- **Ocean:** *SeaWinds*

**Future Mission*

Predictions

- Severe Local Storms
- Weather Forecasts
- 12 Month Global Seasonal Precipitation Forecast
- Seasonal Forecast
- Land Use Projections

- Cloud System Structure
- Land Cover/Use
- Land Surface Temperature
- Soil Moisture
- Ocean Surface Winds
- Global Precipitation
- Total Aerosol Amount
- Land Surface Topography

Observations

DECISION SUPPORT TOOLS

- **RETScreen**
  - Provides common platform for evaluating project proposals while significantly reducing the costs and uncertainties of preliminary studies
  - Reduces the time and errors of a preliminary study

VALUE & BENEFITS

- Optimize renewable energy systems for power production
- Optimal integration of traditional and renewable energy supply systems into electric power grid
- Improved prediction of electric power need and supply – mitigate power shortages, prevent price increase
- Reduction in greenhouse emissions from energy production

Energy Management

June 17, 2003, J. Collier

State 2 - Enhanced DSS (RETScreen, NRCan), incorporating NASA observations and predictions.

Historic SRB Data
- Observations (25+ yrs)
- Reanalysis (50+ yrs)
•Near-Real Time Products
•Short-term Forecasts
•Long-term Forecasts

Improved capability in DSS resulting from the data, predictions, information products and new science knowledge

Partners:

energy.gov U.S. DEPARTMENT OF ENERGY

UNEP

Natural Resources Canada

Data from missions; Models; Information products; New science

Improved capability in DSS resulting from the data, predictions, information products and new science knowledge

Data from missions; Models; Information products; New science

Improved capability in DSS resulting from the data, predictions, information products and new science knowledge

20+ year SRB Climate Data (aerosols, cloud structure, diurnal cycles, surface properties, horizontal/vertical resolution)

Improved capability in DSS resulting from the data, predictions, Information products and new science knowledge

GEWEX SRB (15+ year data)

CERES SARB (1-2 year data)

Improved capability in DSS resulting from the data, predictions, information products and new science knowledge

Current trajectory:
Steady improvement in item A, item B, and item C.

State 1-Current DSS (RETScreen, NRCan):


TRMM


Terra


Aqua

CloudSat/Calipso


NPOESS

Socioeconomic Impact

An operational decision support system for an application of national importance

2000 2002 2004 2006 2008 2010

Energy Management:
Prediction of Worldwide Resources

Surface Solar Energy Project

Objective

To synthesize and convert scientific data to renewable energy industry standards

History

- NASA Surface Radiation Budget Project develops surface solar insolation data set for solar cooking w/ DOE/NREL
- February 1998, “Development of Surface Solar Energy Data Sets for Commercial Applications for Placement of Solar Power Facilities” proposal funded by NASA
- Meteorological data added (surface temperature, moisture and winds)

NASA's National Applications Homeland Security

Homeland Security: DHS Situation Center
Preparation, Mitigation, Warning, & Response

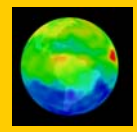
6/17/2003
S. Ambrose

State 2-DHS Situation Center (c. 2012):
- Prepared with integrated data streams
- Information for warnings & alerts
- Rapid data to support responders and officials with info & analysis

Primary Partners:

USGS science for a changing world

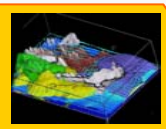
- Day/night air monitoring
- Trace gas measurements
- Improved circulation models



Outcomes: Streamline tasking for priority threats and flow of information.

Impacts: Reduce major illnesses and deaths from events.

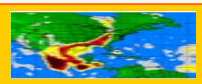
- Long-range deposition
- Bio-optical detection sensors and buoys
- Plume transport visualizations



Outcomes: Rapid identification of air/water biological agents. Trace sources & destinations Issue health alerts.

Impacts: Manage public reaction, fear, and over-reaction.

- Plume chemistry and speciation
- Robust satellite data assimilation
- Aerosol & trace gas characteristics



Outcomes: HAZUS Improved information for first responders and recovery efforts. Warnings to food handlers & water treatment plants.

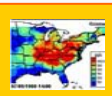
Impacts: Reduce exposure to first responders. Minimize extent of economic impacts.

- Plume advection/deposition
- UAV monitoring and rapid response communications links
- Visualization/interoperability

Outcomes: Identify downstream exposure to airborne/waterborne contaminants. Increase warning time to people/officials .

Impacts: Reduce health effects and exposure to livestock. Reduce hospital admissions and lost productivity.

- Simulation planning
- Risk assessment
- Sensor validations/verifications

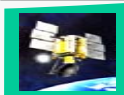


Outcomes: Scenario coordination and planning for organized response. Coordinate with Homeland Security Tiger Team

Impacts: Minimize subsequent exposure to populations and secondary effects.

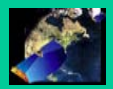
Current trajectory: Improvements in plume modeling, risk assessment, sensor capabilities, visualizations and damage assessment.

State 1-DHS Situation Center (c. 2004): Early formation stage.


QuikSCAT


UAVs


Aqua


GRACE


AERONET


Aura


CloudSat


MOBY


GIFTS


NPOESS

* Pre-formulation

2003 2004 2005 2008 2010 2012

Socioeconomic Impact

Improved capabilities to Department of Homeland Security to prepare, warn, and respond to homeland threats, especially air and water exposure.

NASA's National Applications Ecological Forecasting

Ecological Forecasting
Integrated System Solutions

EARTH SYSTEM MODELS

- Ecological Niche (GARP)
- Scalable spatio-temporal models a la CSU's NREL
- Regional Ocean Models & Empirical Atmospheric Models coupled with ecosystem trophic models
- Ecosystem (ED, CASA)
- Population & Habitat Viability Assessment (VORTEX, RAMAS GIS)
- Biogeography (MAPSS, BIOME3, DOLY)
- Biogeochemistry (BIOME-BGC, CENTURY, TEM)

**Supported Non NASA Model*

- Species Distributions
- Ecosystem Fluxes
- Ecosystem Productivity
- Population Ecology
- Land Cover Change

Data

MONITORING & MEASUREMENTS

- *Land cover* MODIS, AVHRR, Landsat, ASTER, ALI, Hyperion, IKONOS/QuickBird
- *Topography/Vegetation Structure* SRTM, ASTER, IKONOS, LVIS, SLICER, Radars
- *Primary Productivity/Phenology* AVHRR, SeaWiFS, MODIS, Landsat, ASTER, ALI, Hyperion, IKONOS, QuickBird, AVIRIS
- *Atmosphere/Climate* AIRS/AMSU/HSB, TRMM (PR, LIS, TMI), AVHRR, MODIS, MISR, CERES, QuikScat, SeaWinds
- *Ocean* AVHRR, SeaWiFS, MODIS, TOPEX/Poseidon, JASON, **AQUARIUS**
- *Soils* AMSR-E, AIRSAR

**Future Mission*

- Land Cover/Land Use & Disturbances (e.g., fire)
- Species Composition
- Biomass/Productivity
- Phenology
- Vegetation Structure
- Elevation
- Surface Temperature
- SST, SSH, Circulation, & Salinity
- Atmospheric Temp.
- Soil Moisture
- Precipitation
- Winds

Observations

DECISION SUPPORT TOOLS

- **SERVIR (Spanish acronym for Regional Visualization & Monitoring System)**
  - Monitor changes in land cover, weather, & fires to assist the sustainable management of the Mesoamerican Biological Corridor
- **Protected Area Monitoring System with ALDO & TOPS**
  - Coordinate multi-NGO effort to pool resources for monitoring protected areas
  - Link to President's logging initiative & CBFP
- **Impact of ENSO & PDO Events on Fisheries**
  - Combine physical ocean & ecosystem trophic-level models to predict how climatological changes driven by ENSO & PDO events will affect regional fisheries

VALUE & BENEFITS

- Firstever effort to manage a global hotspot of biodiversity, i.e. Mesoamerica, at a regional scale through the coordination of the activities of 7 countries – a model for other regions
- Predict the impacts of changing land-use patterns & climate on the ecosystem services that support all human enterprises
- Develop ecological forecasts with reliable assessments of error

Ecological Forecasting

(10/16/2003 W. Turner)

Socioeconomic Impact

Integration of remotely-sensed data with various model types, e.g.: ecosystem, ecological niche, population & habitat viability, biogeography, biogeochemistry, & regional ocean & atmospheric models -- as well as the development of new predictive models

"If-Then" Scenarios for Ecosystem Responses to Change/Disturbance

Ongoing global land cover change product; global precipitation data

Species Distribution Forecasting System > biodiversity/stability/ productivity links

Soil surface moisture, sea surface salinity, global river discharge measurements

Species distribution models with improved accuracy

Vegetation structure & disturbance from active sensors; new data on physiology & functional groups (hyperspectral/fluorescence)

Operational SERVIR, Protected Areas Management System, & Marine Fisheries Forecasting System DSS's

Regional ocean models coupled to ecosystem models; global land cover change product

Prototype Marine Fisheries Forecasting System DSS for fisheries management; also Protected Areas Management System DSS incorporating species habitat & demographic data into a planning tool

Prototype predictive models linking remotely-sensed environmental parameters to changes in terrestrial & aquatic ecosystems

Initial operation of Regional Monitoring & Visualization System DSS (SERVIR) for environmental management & sustainable development in Central America

Current trajectory

EOS & global land cover observations; early coupling of regional climate & ecosystem models

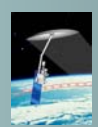
Assessment of land cover change/climate impacts on ecosystems

Steady improvement in models linking functional, structural, spatial, & temporal environmental measurements (ongoing measurements include: land cover, ocean color, primary productivity)

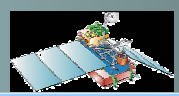
Operational ecological forecasting systems supporting environmental & natural resource management for sustainable development

TRMM

SRTM



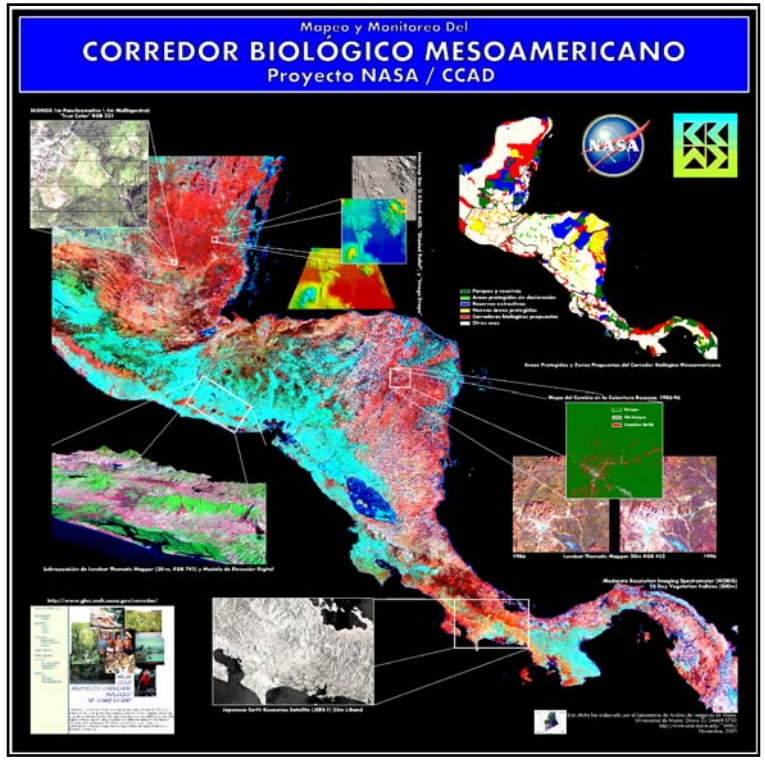
HYDROS



Landsat 7 **Terra** **Aqua** **NPP/VIIRS** **LDCM** **Aquarius** **GPM** **NPOESS**

2003 **2005** **2007** **2009** **2011** **2013**

Ecological Forecasting



Ecological Predictions in a Changing World for Better Resource Management

SERVIR – a regional visualization & monitoring system for the Mesoamerican Biological Corridor tracking:

- ***Fires***
- ***Changes in land cover***
- ***Rainfall***
- ***Severe Weather***
- ***Coral Reef Health***
- ***Urban Development***

Backup Slides

Part I: GIO PROGRAM OVERVIEW
Part II: Related Earth Science Enterprise Applications Division Charts

National Science and Technology Council's Physical Infrastructure Working Group

November 21, 2003

Backup Slides

Part I: GIO PROGRAM OVERVIEW

National Science and Technology Council's Physical Infrastructure Working Group

November 21, 2003

Geospatial Interoperability Program

- Who we are
- Goal of Program
- ESE Benefits
- NASA Projects
- GAI: Strategic & Operations Plans
- Geospatial One-Stop
- Standards
- Decision Support
- Products & Services

Who We Are

- Level II function that directly supports the ESE Applications strategy and manages NASA participation in Geospatial Standard committees (i.e. FGDC, OGC, ISO TC211)
  - Customers: HQ/ESE, CIO & JX , ESDIS, SEEDS, ESTO, Federation, Synergy, and all NASA Centers
  - Alignment/Collaborations: FGDC/GAI WG, IEEE, ISPRS/ASPRS, Digital Earth, etc.
  - Agency advocate on geospatial interoperability
  - Provides Agency focus for Federal Mandates such as Geospatial 1-Stop & FEA
  - Develops Agency consensus on geospatial interoperability standards--beyond the scope of individual projects

Goal of Program

- Goal: Enable government, industry, scientists and citizens to gain knowledge or make decisions through application of geospatial information
- Objectives:
  - Geospatial Standards Leadership
  - Partnerships / Alignments
  - Support and leadership in President's Management Agenda
  - Support of ESE National Applications
  - Outreach & Education
  - International Representation

Capabilities

- Manage, influence and coordinate Agency participation in Geospatial Standard committees and organizations
  - Strategic Agency Approach
  - Standards Development Expertise
- Business perspective for alignments & industry partnerships
- Chair/Lead the Geospatial Applications and Interoperability Working Group within FGDC, and serve as NASA's Coordination Committee Member to FGDC [emphasis on Geospatial One-Stop]
- Perform outreach between federal agencies, academia and industry
  - Community meetings
  - NAS workshop
- Participate in the International Steering committee for Digital Earth and the Global Spatial Data Infrastructure (GSDI)

ESE Benefits

- Supports ESE Strategic Plan / Enhances Strategic 10 Year Applications Plan
- Level II Resource with agency interoperability focus
- Focus for Geospatial One-Stop
- Influences standards to ensure they meet NASA's requirements
- Promotes Geospatial Interoperability across the Agency
- Connects ESDIS, SEEDs,ESTO and NASA Center interests of interoperability through Standards leadership, representation, and participation
- Offers an international representation and influence to protect NASA's interests in Geospatial Information

Support on NASA projects

- GIO is NASA lead for OGC Web Services
- ESTO
- ESDIS
- NewDISS (SEEDS)
- GSFC Global Change Data Center (GCDC)
- JPL GeoTIFF, WMS Global Mosaic
- University of Alabama Huntsville
- EROS Data Center
- Ames Research Center
- ESIP Federation

GAI Plans

- Strategic Plan
  - Vision : Facilitates use of location relevant data in decisions. Builds on the NSDI by promoting technology and standards for seamless access to distributed geographic data & services.
  - Goals
    - Advance the application of interoperable geographic information to a variety of areas
    - Educate the community at large about the value of geospatial interoperability using developed standards
  - Objectives
    - Develop & Maintain a Reference Model
    - Promote collaborations between the Geospatial & IT communities
    - Support E-Gov Initiative's Geospatial One-Stop
    - Community Awareness & Participation
- Visit Us at http://gai.fgdc.gov/
- Open Meetings
- Open participation

Geospatial One-Stop

- Module 1: Data Content Standards Development and Cost Benefit Analysis
- Module 2: Inventory and Document Existing Framework Data
- Module 3: Inventory and Document Planned Data Collection Activities
- Module 4: Interoperable Web Mapping, Data Access and Catalog Services
- Module 5: Deployment of Commercial-grade Portal accessing those services

Geospatial One-Stop

- E-Gov Initiative has 26 major areas
- E-Gov and Homeland Security
- NASA

	NASA POC
• E-Gov	Pat Dunnington
• Geospatial One-Stop	
– Federal Partner & Board of Directors	Ron Birk
– Agency POC	Myra Bambacus
• Current Calls	
• OMB examiner	Ron Birk
• Current and Planned Metadata	Myra Bambacus

Geospatial One-Stop

- **Mutual benefits:**
  - **Partnerships Planned Data Acquisitions**
  - **standardized access to other agencies' validated data**
  - **framework in which to contribute NASA data**

- **NASA chairs FGDC Geospatial Applications & Interoperability (GAI) working group; GAI leads Module 4 (service deployment).**

- **Not a Framework Theme Lead Agency, but participates in framework data standards teams**

Geospatial Standards Bodies

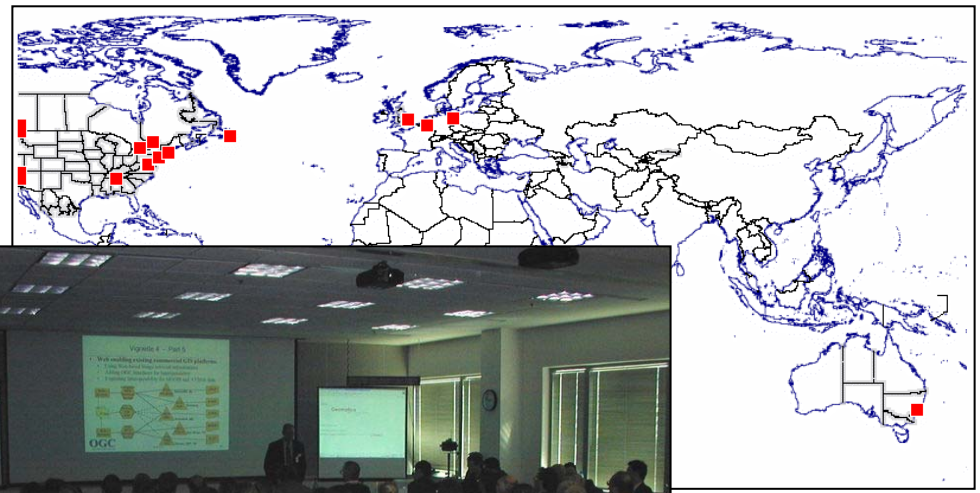
- OpenGIS Consortium
  - www.opengis.org
  - Not for profit consortium
- ISO TC211- Geographic Information
  - www.isotc211.org
  - Technical Committee of ISO
  - US Delegation; INCITS - L1
- Federal Geographic Data Committee
  - US Federal government directive
  - www.fgdc.gov
  - GAI WG

OGC Interoperability Program

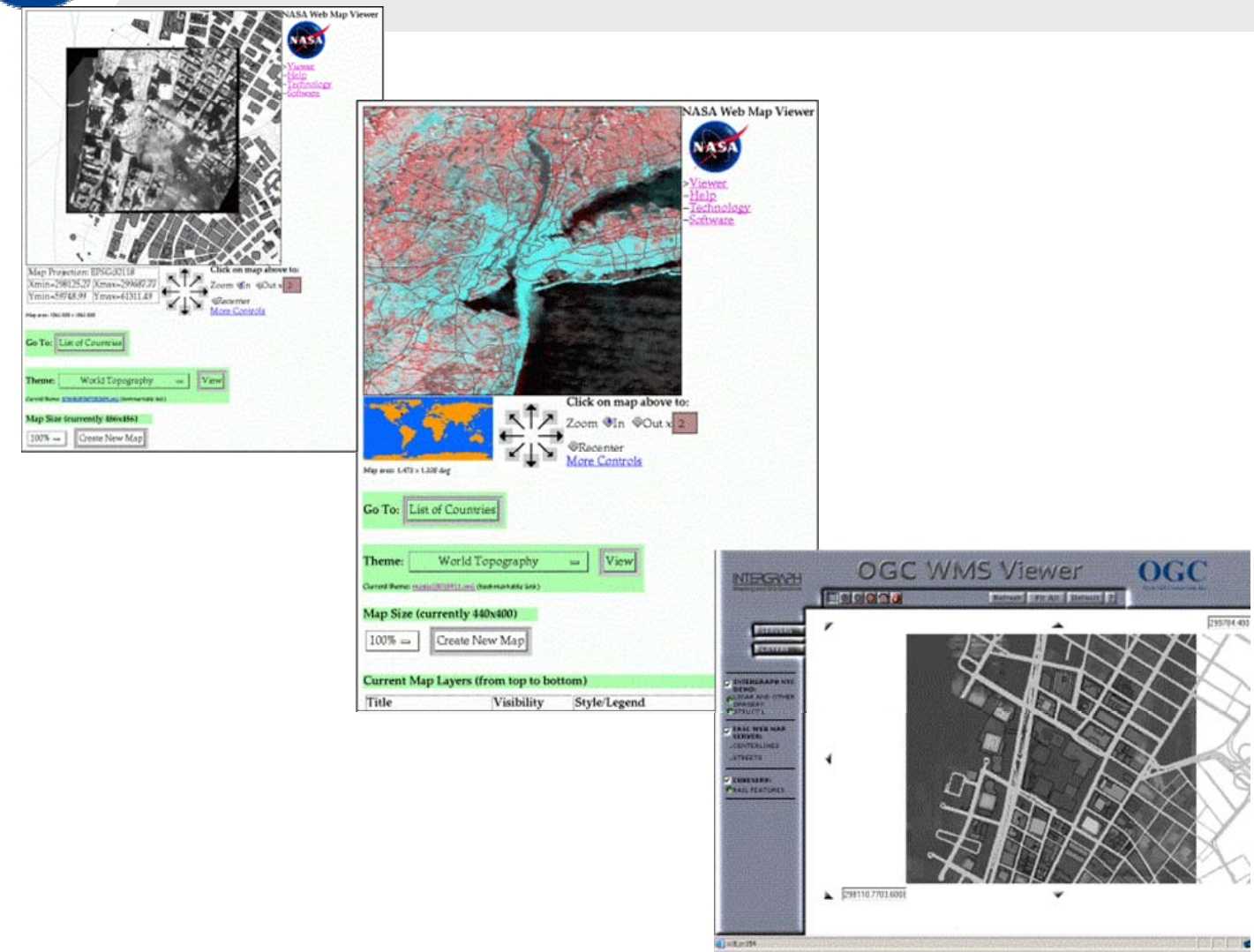
- OpenGIS Consortium(OGC) Interoperability Program
  - Multi-vendor, multi-agency collaboration
  - Concurrent specification and implementation
  - Web Mapping Testbed
  - OGC Web Services
- NASA participation
  - Sponsor of past testbeds
  - Jeff de La Beaujardiere, Editor Web Mapping Service
    - ISO TC211
  - John Evans, Editor Web Coverage Service
  - Multiple NASA Implementations
  - Committed to NASA sponsorship in OGC Web Services (OWS-2)

OGC Web Services (OWS)
OWS 1.1 Demonstration

- Conducted live and worldwide on the Internet on March 7, 2002
- Clients in Chantilly, Virginia, USA but the servers are all over the world –
  - Canada – 5 locations
  - Sioux Falls, SD
  - Huntsville, AL
  - Boston, MA
  - Washington, DC (multiple servers)
  - Greenbelt, MD
  - Fort Belvoir, VA
  - Liege, Belgium
  - Cambridge, UK
  - San Diego, Pasadena, Redlands, C
  - Sydney, New South Wales Australi
  - St Louis, MO
  - Vancouver, BC
  - New York City,Palisades, NY



OWS –
Imagery Access and Visualization



Geographic Interoperability Office

- Standards are critical to geospatial interoperability and applications
- GIO leads NASA geo-standards efforts
- Implementation of standards by NASA programs is critical to success

GIO Products & Services

- Geospatial Standards & Interoperability Program Leadership
  - Holds Agency Membership in Applicable Standards Bodies
  - Manages / Coordinates Agency Participation
  - Leverages Agency funding for interoperability testbeds
- Federal Geographic Data Committee Responsibility
  - Agency Coordination Committee Representative
  - Chair, Geospatial Applications and Interoperability Working Group
  - Reference Model for Geospatial Standards
- Agency advocate on geospatial interoperability
- Agency focus for Federal Mandates such as Geospatial 1-Stop & FEA
- Business perspective for alignments & industry partnerships
- Outreach community meetings between federal agencies, academia and industry
- International Steering committee for Digital Earth

Backup Slides

Part II: Related Earth Science Enterprise Applications Division Charts

National Science and Technology Council's Physical Infrastructure Working Group

November 21, 2003

Applications of National Priority

- Weather and climate for **Agricultural Efficiency**
- Sequestration capacity monitoring for **Carbon Management**
- Biological **Invasive Species Management**
- **Water Management** and conservation
- Weather and natural hazards for **Air Quality** management
- Weather and climate for **Energy Management**
- Weather and natural hazards for **Aviation**
- Weather and climate– **Ecological Forecasting**
- Early warning for **Homeland Security**
- Early warning for **Public Health**
- Community preparedness for **Disaster Management**
- Environmental Indicators for **Coastal Management**

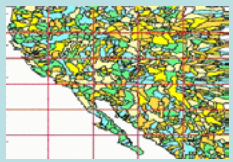
Integrating Earth System Models Outputs

LAND

GTEC
Terrestrial Ecosystem Carbon

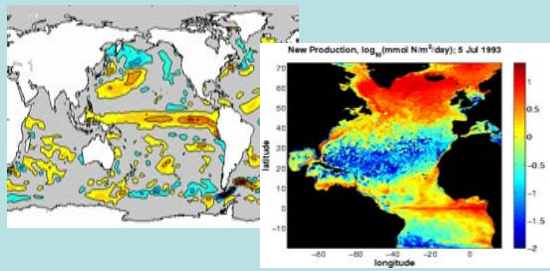
Mosaic	*Energy, water fluxes*
CENTURY	*Land change/carbon*
VolQuake	*Seismicity*
HSPF	*Nutrient transport*
ANIMO	*Soil nitrogen cycle*
PRMS	*Precipitation run-off*
MAESTRO	*Canopy biomass*

Catchment LSM
Soil Moisture Transport



OCEANS/ICE

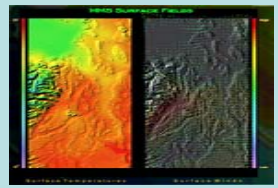
ROMS	*Regional circulation*
MOM3	*Multi-scale ocean*
CSIM4	*Sea-ice*
NWW3	*Global/regional waves*
BOM	*Coastal & shelf seas*
GOTM	*Turbulence & mixing*



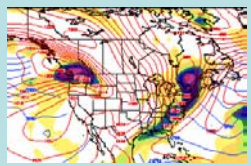
Poseidon, HYCOM
Ocean GCM

ATMOSPHERE

MM5
Mesoscale Meteorology



CAM/CCM	*Global climate*
GISS GCM	*Climate change*
BEIS	*Biogenic emissions*
MSISE	*Density, temperature*
VAFTAD	*Volcanic ash*
PRECIS	*Regional climate*

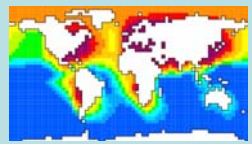


Aries/GEOS
Atmos. GCM

COUPLED MODELS

COUPMODEL
Soil-Plant-Atmosphere

LOIS	*Land-Ocean*
HadCM3	*Ocean-Atmosphere*
COLA	*Atmosphere-Land/Biosphere*
ZEUS, CCSM	*Land-Ocean-Ice-Atmosphere*



AOM
Atmosphere-Ocean

NASA Models (some)

- Data Assimilation Office
  - **Atmosphere, land-surface assimilation, assimilated data for mission support, observation impact, link between weather and climate. Built-in tracer transport capability**
- Goddard Institute for Space Studies
  - **Climate forcing, multi-decade, centennial assessment**
- NASA Seasonal-to-Interannual Prediction Project
  - **Ocean and Land Assimilation, Ocean-land-atmospheric interactions 6 –24 months**
- Global Modeling Initiative
  - **Assessment of changes in tropospheric and stratospheric ozone, impact of aircraft and rockets on atmosphere**
- Modeling in Research and Analysis Program
  - **Earth system process modeling and model integration**

Future Direction: Earth Science Modeling Framework (ESMF)

Development of software environment to facilitate collaboration and controlled numerical experimentation

(NASA, NOAA, MCS, MIT, NCAR, DoE)

Decision Support Systems (DSS)

Enable scenario-based evaluations, alternatives analysis, what ifs

Support for unstructured decision-making requirements

Provides systematic approach to evaluate value of information and value of decisions

Support risk assessments, critical uncertainties, sensitivity analysis, plausible futures

Key Challenges

Identifying questions-to-address and requirements

Knowing assumptions and limitations of DSS

Know limitations of datasets and models feeding the DSS

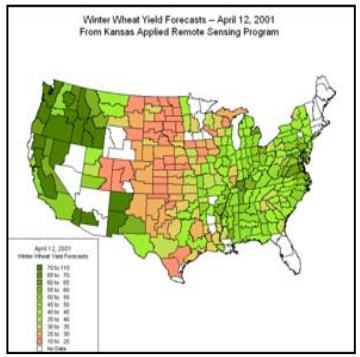
Complementary assets (visualization, data integration, computation)

Key NASA Capabilities

- Assimilate NASA Earth Science data into Federal partners' DSS
- Systems engineering approach to requirements
- Success with QuikSCAT, MODIS, FEMA 37 specifications

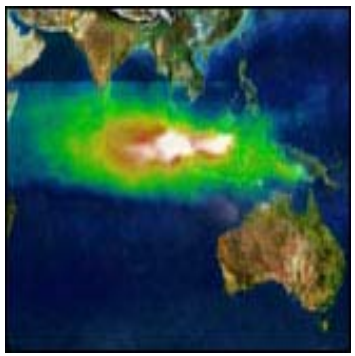
Benchmarking Decision Support Systems

Agricultural:
CADRE – Global Production

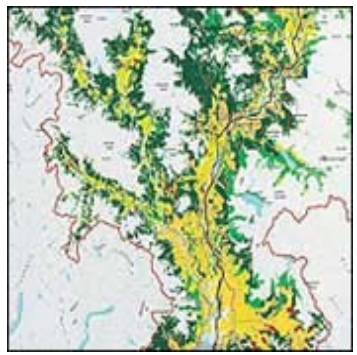


Carbon Management:
1605 (b) Permitting

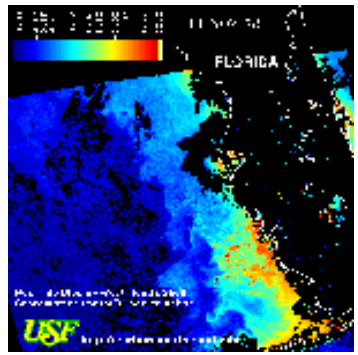
Invasive Species:
Prediction Center



Air Quality:
Community Multi-Scale Air Quality



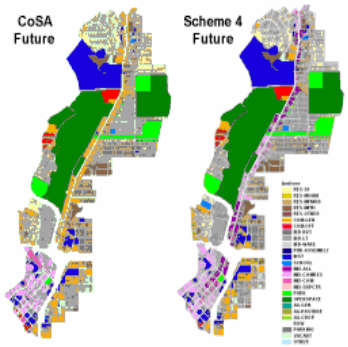
Water Management:
AWARDS, RiverWare



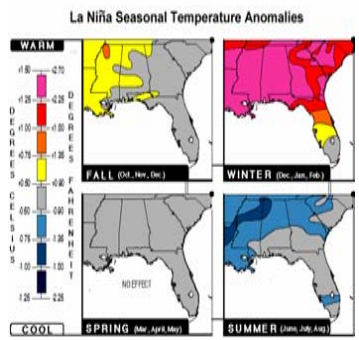
Coastal Management:
Harmful Algal Bloom Forecast

Benchmarking Decision Support Systems

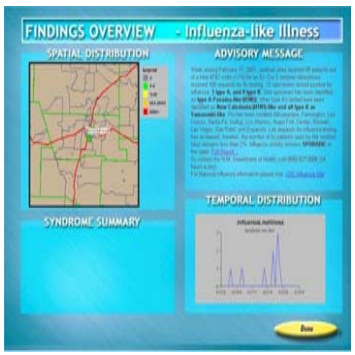
Aviation:
National Airspace System



Ecological Forecasting:
SEVIR

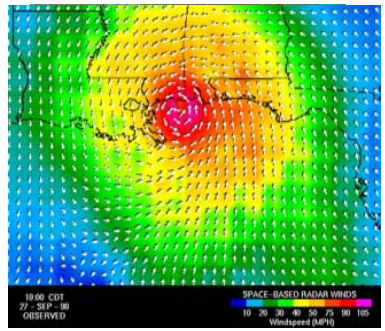


Energy Management:
Renewable Energy System



Public Health:
EPHTN

Homeland Security:
Situation Center



Disaster Management:
HAZUS Risk Prediction

Integration of Data Layers

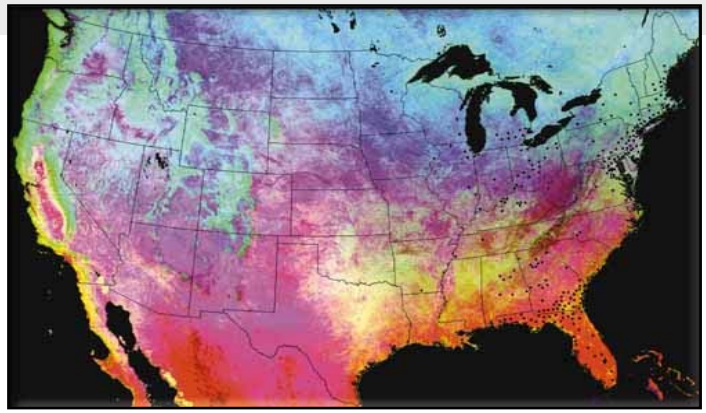
Precipitation

Land-cover/Land-use

Vegetation Condition (NDVI)

Soil Moisture

Meteorology

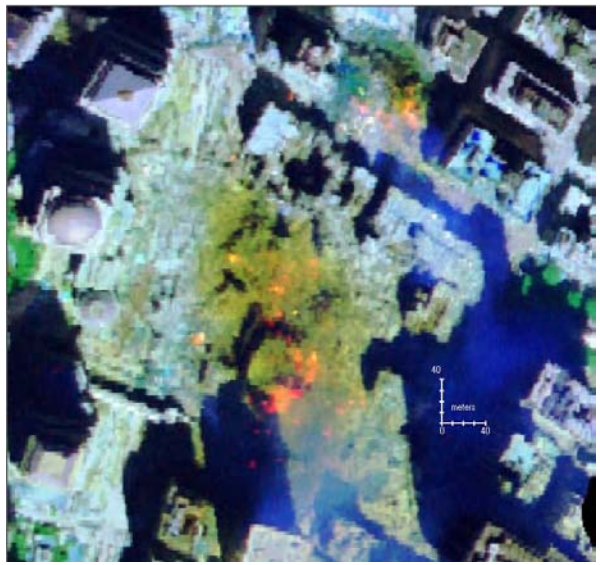


Risk map of West Nile Virus based on imagery and Earth science data.

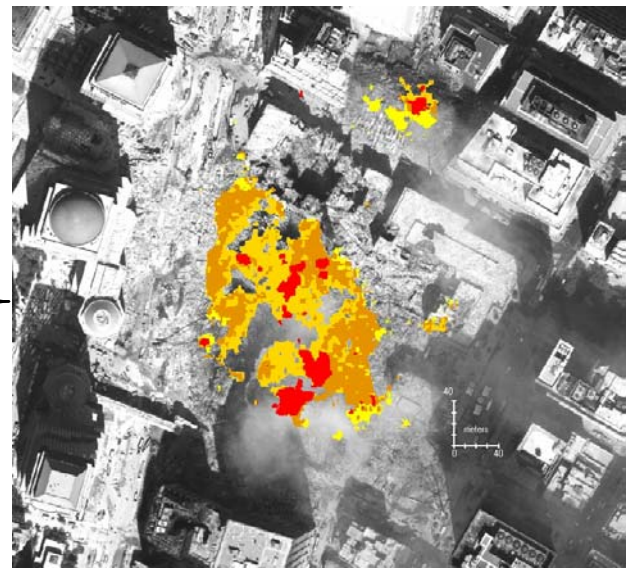
source: NASA-GSFC

High spatial resolution panchromatic

Course resolution hyperspectral



Fused information product showing fires



Socioeconomic Benefits

National Applications	Estimated Economic Benefits	Citation
Energy Forecasting 	**$9.58 B / yr** Estimated annual benefit from implementation of the POWER Project (Biomass Energy Industry and Energy Resource Planning Phases only; average for 2002-2017)	LARC Report: *An Estimate of NASA/ESE/POWER Program Benefits to the U.S. From 2002 through 2017*, June 3, 2002.
Carbon Management 	**$150B / yr** Cost savings by soil sequestration for meeting the WRE Carbon 550 Emissions constraint as determined by the MiniCAM model	*Carbon Sequestration in Soils: Science, Monitoring and Beyond*; St. Michaels Workshop, Dec 1998
Agricultural Competitiveness 	**$300M / yr** Projected annual benefit from improved crop prediction based upon better climate forecasting	*NOAA Strategic Plan*: *A Vision for 2005*; September 1998

Socioeconomic Benefits

Air Quality Management 	350,000 fewer cases of aggravated asthma & 5,000 premature deaths 1 million fewer cases of reduced lung function in children $500 million estimated from ozone reductions…EPA estimate of annual benefit from adopting new NAAQS standards	EPA Fact Sheet, June 25, 1997 EPA Fact Sheet, July 17, 1997 US EPA, National Air Quality and Emissions Trends Report, March 2001
Disaster Management 	**$240M / yr** Reduction in losses/yr to the Property and Claims industry through adoption of geospatial technologies estimate $100M per typical hurricane if 24 hour evacuation predictions could be improved to 300 miles of coastline	Insurance Services Office (ISO), 2002. *Weather Impacts, Forecasts and Policy,* March 2002 BAMS
Public Health 	**$200M / yr** Amount that could be reduced to contribute to managing risks for asthma.	Johns Hopkins School of Public Health, May 2000

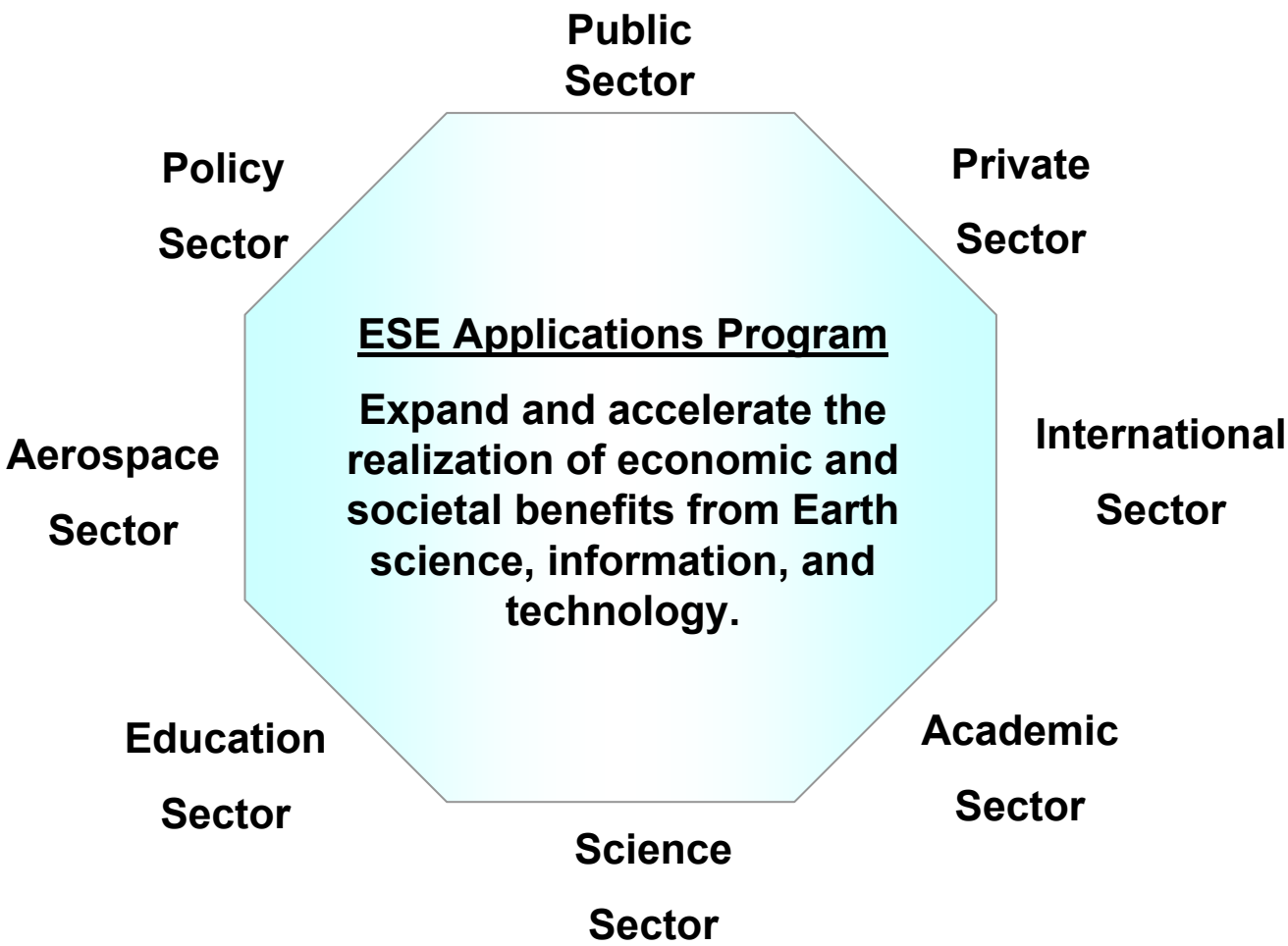
Socioeconomic Benefits

Coastal Management 	Reduce economic impacts from harmful algal blooms (HABs) affecting 1) public health 2) commercial fishery 3) recreation and tourism 4) monitoring and management costs	WHOA Technical Report 1999
Invasive Species 	**$140 to $408M / yr** Estimated aggregated benefit of reduced environmental damage, reduced crop yield losses and decreased use of herbicides	Office of Technology Assessment (OTA). Report OTA-F-565, 1993.
Water Conservation/ Management 	**$11B / yr** Approximation of partial benefits of current water quality levels as compared to what they would have been w/o water pollution control programs	Application Profile (U.S. EPA)

Socioeconomic Benefits

Aviation Safety 	**$1.66 B / yr** Average annual savings combined from using synthetic vision system (SVS) to improve airport capacity and delay efficiencies at 10 U.S. airports	NASA Langley Research Center, July 2000
Ecological Forecasting 	**$10.6 B / yr** Economic impact of U.S. National Parks for the year 2001, includes expenditures and job creation in and around National Park Service areas (Protected area management is a key focus area for the Ecological Forecasting application.)	National Park Service Money Generation Model 2 (MGM2) estimates contained in: Economic Impacts of National Park Visitor Spending, Servicewide Estimates for 2001

Stakeholder Communities



Collaborating with Earth Science Laboratories

GISS

JCSDA

Laboratory for Terrestrial Physics

Laboratory For Hydrospheric Processes

NASA Goddard Space Flight Center
LABORATORY FOR ATMOSPHERES

GHCC

SPORT

GFDL
Geophysical Fluid Dynamics Laboratory
Princeton, NJ

National Centers for Environmental Prediction

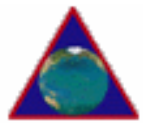
ARL

Office of Research and Applications

Data Assimilation Office

NCAR

Public Sector Partners



MISSISSIPPI
SPACE
COMMERCE
INITIATIVE

Research Sector Partners

Private Sector Partners